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$p=96$, $h=91.7=92$ say, $B=94$, $B'=83$.

$\therefore t=\pi/C\,(4.3093+90.3161+409.9964)=1.76848\pi=5$ hours, 33 minutes, 21 seconds.

The actual time observed for filling this tank to within 4 inches of the top was $5\frac{1}{2}$ hours.

MISCELLANEOUS.

149. Proposed by **F. P. MATZ, Ph. D., Sc. D.**

Given $\sin^{-1}u+\sin^{-1}\frac{1}{2}u=\frac{1}{4}\pi$, to find u.

Solution by **J. EDWARD SANDERS.**

By use of the addition theorem, we have

$$\tfrac{1}{2}\sqrt{2}=u.\tfrac{1}{2}\sqrt{(4-u^2)}+\tfrac{1}{2}u.\sqrt{(1-u^2)}.$$

Squaring twice and arranging, we get the trinomial $17u^4-20u^2=-4$, or $u=\pm\sqrt{(\frac{10}{17}\pm\frac{4}{17}\sqrt{2})}$. Whence $u=\pm.50544945$......... or $\pm.95968298$.........

The first value is the one solving the question.

Also solved by R. D. Carmichael, G. W. Greenwood, A. H. Holmes, L. E. Newcomb, J. Scheffer, W. L. Tryon, G. B. M. Zerr, and the Proposer.

150. Proposed by **T. N. HAUN**, Mohawk, Tenn.

If $\dfrac{\sin\phi}{\sin\psi}=m$, find maximum and minimum value of $\dfrac{\sin(\phi+\theta)}{\sin(\psi+\theta)}$, where θ is known.

I. Solution by **A. H. HOLMES.**

$$\frac{\sin\phi}{\sin\psi}=m.\quad \therefore \sin\phi=m\sin\psi \text{ and } \cos\phi=\sqrt{(1-m^2\sin^2\psi)}.$$

$$\therefore \frac{m\sin\psi\cos\theta+\sin\theta\sqrt{(1-m^2\sin^2\psi)}}{\sin\psi\cos\theta+\sin\theta\sqrt{(1-\sin^2\psi)}}=\text{maximum or minimum.}$$

Differentiating, etc.,

$$\sin^4\psi-\frac{2\cos^2\theta(m^2+\sin^2\theta+\cos^2\theta)}{(m^2-\sin^2\theta+\cos^2\theta)^2+4\sin^2\theta\cos^2\theta}$$

$$=-\frac{\cos^4\theta}{(m^2-\sin^2\theta+\cos^2\theta)^2+4\sin^2\theta\cos^2\theta}.$$

$$\therefore \sin\psi=\frac{\cos\theta}{\sqrt{(m^2-2m\sin\theta+1)}} \text{ for maximum,}$$

$$\text{and } \sin\psi=\frac{\cos\theta}{\sqrt{(m^2+2m\sin\theta+1)}} \text{ for minimum.}$$

$\therefore$ Maximum value of $\dfrac{\sin(\phi+\theta)}{\sin(\psi+\theta)}=\dfrac{m+\sin\theta}{1+m\sin\theta}$ when $\theta+\phi+\psi=\frac{1}{2}\pi$; and similarly=minimum when $\theta+\phi+\psi=3\pi/2$.

II. Solution by G. B. M. ZERR, A. M., Ph. D.

$$\frac{\sin\phi}{\sin\psi}=m,\quad \frac{\sin(\phi+\theta)}{\sin(\psi+\theta)}=u=\text{maximum and minimum.}$$

$$\therefore \cos\phi\ \sin\psi\ d\phi-\cos\psi\ \sin\phi\ d\psi=0.$$

$$\cos(\phi+\theta)\sin(\psi+\theta)d\phi-\cos(\psi+\theta)\sin(\phi+\theta)d\psi=0.$$

$$\therefore \tan(\psi+\theta)\tan\phi=\tan\psi\ \tan(\phi+\theta).$$

$$(\tan\phi-\tan\psi)(1-\tan\phi\ \tan\psi-\tan\theta\ \tan\phi-\tan\theta\ \tan\psi)=\upsilon.$$

$\therefore \phi=\psi$ and $\theta+\phi+\psi=\pi/2$ or $3\pi/2$. ϕ cannot$=\psi$ unless m=unity.

$$\therefore \frac{\sin(\phi+\theta)}{\sin(\psi+\theta)}=\frac{\cos\psi}{\cos\phi}=u.$$

$$\sin\phi=m\sin\psi=m\cos(\phi+\theta) \text{ or } -m\cos(\phi+\theta).$$

$$\therefore \tan\phi=\frac{m\cos\theta}{1+m\sin\theta} \text{ or } \frac{m\cos\theta}{m\sin\theta-1}.$$

$$m\sin\psi=\cos(\psi+\theta) \text{ or } -\cos(\psi+\theta).$$

$$\therefore \tan\psi=\frac{\cos\theta}{m+\sin\theta} \text{ or } \frac{\cos\theta}{\sin\theta-m}.$$

$$\therefore u=\frac{m+\sin\theta}{1+m\sin\theta}=\text{maximum when } \theta+\phi+\psi=\pi/2.$$

$$u=\frac{\sin\theta-m}{m\sin\theta-1}=\text{minimum when } \theta+\phi+\psi=3\pi/2.$$

PROBLEMS FOR SOLUTION.

ALGEBRA.

244. Proposed by ELMER SCHUYLER.

Solve $(x+1)(y-1)=a(x-1)(y+1)$; $(x^5-1)(y-1)=b^2(y^5-1)(x-1)$.

245. Proposed by SAM I. JONES, A. B., Gunter Bible College, Gunter, Texas.

The shell of a hollow iron ball is 4 inches thick, and contains $\frac{1}{5}$ of the number of cubic inches in the whole ball. Find the diameter of the ball.

246. Proposed by J. EDWARD SANDERS.

Find in terms of the roots the area common to the two curves $x+y^2=a$ $(=\frac{70}{9})$ and $x^2+y=b(=\frac{28}{9})$. What are the conditions that the roots are all real? Are there values of a and b that will make all the roots rational?